Tap Controlled Augmentative and Alternative Communication Device

Efficiency and Availability of Augmentative and Alternative Communication Devices

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By
Goutham Mittadhoddi

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ADVISORS

Alice Fox, Department of Engineering and Society

Adam Barnes, Department of Electrical and Computer Engineering

Efficiency and Availability of Augmentative and Alternative Communication Devices

This project is an exploration of the types of technology available to aid in communication when a person's capacity for verbal communication is hindered or non-existent. The project also includes a rating/ranking of the efficiency of communication and information storage of each method. A cool thing readers might learn are the different characteristics of AAC devices and how those characteristics are tailored towards different use cases.

Problematization:

The main problem being addressed is the usage of augmentative and alternative communication devices in people with communication limitations. There are a wide variety of reasons to use an AAC device, and many variations of AAC devices to match each need. Through this paper we explore how certain designs of AAC devices are better suited for certain purposes, and how the design and availability of these devices can be improved.

Guiding Question or Main Argument:

How can we improve the design of AAC devices to allow users to express their thoughts better? The diversity of AAC devices as well as the specific usage restrictions of each person that needs an AAC device requires a deeper understanding of what a design improvement would look like.

Projected Outcomes:

The research aims to analyze the current experiences that users have of AAC technologies and find potential areas of improvement. Ideally, an improvement can be found, either in efficiency of communication or accessibility due to cost or availability. Those needing AAC devices would benefit from the presence of a new, more efficient, or more accessible solution.

Technical Project Description:

This research project is paired with the actual design and construction of an AAC device that will be later evaluated along with devices found with this project. The device will attempt to convert extremely basic input (tapping a button) to English text. The design of this will require experimentation with methods of information storage and translation for its function as well as experimentation with using more affordable tools and materials in its construction.

Preliminary Literature Review & Findings:

The evaluation of users' experiences with AAC devices is a difficult endeavor. There is a wide variety of reasons for which a person chooses to use an AAC device. This variety of reasons also means that there is a wide variety of ability that affects how well a particular device design suits a person. Since this is a problem of communication, the devices may not perform equally across different languages. This makes it difficult to produce a unified statement on AAC

devices. On top of this, the evaluation of an individual's experience is difficult on its own. Currently, the random controlled trials to evaluate AAC interventions are the most popular but are of low quality. The semi-structured interviews of users and their families and teachers are time-consuming, and studies find it difficult to conduct these with large sample sizes. The debate surrounding AAC devices is also niche in the medical community, leading to fewer people researching the subject.

In spite of this some engineering research to improve the devices continues. Research on user-adaptive text entry seeks to characterize common mistakes the user makes in inputting what they want to communicate to provide choices for them to express themselves correctly. Research on fast switch scanning keyboards also seeks to provide choices to the user. The goal of this research is to prompt the user with the right choices so that the number of decisions the user needs to make is minimized. This ranges across various input methods including finger flexion, eye gaze movement, and brain computer interface.

STS Project Proposal:

STS is the process of understanding how science and technology influence and are influenced by society. The existence of these AAC devices is the direct result of a section of society needing assistance to be able to communicate with others in society. The evolution and proliferation of these devices also points to their design being tailored to specific needs within society. Since this project aims to explore the reason why different designs of AAC devices exist and how to improve them, it approaches the devices from a perspective of their impact on society as well as how society impacts them.

This approach to research aligns itself to focus on disability studies as well as healthcare. To make use of as large of an information set as possible, a lot of the source of knowledge will be accumulations of survey data or will be papers written synthesizing the results of survey data. The primary authors will sometimes be engineers working on understanding the impact of AAC devices. They may also be medical professionals or researchers that have more of a first-degree connection with users of AAC devices.

I think a SCOT analysis fits best for the purposes of the research. Since the research and technical components hinge on improving the user experience of finding or using AAC devices, it makes the most sense to pursue research in the context of evaluating and improving the devices.

A literature review best fits this research. It offers the ability to access a significant amount of information, especially in a field where direct interactions are limited, and other sources of information could turn out to be more anecdotal.

Barriers & Boons:

There are many potential blind spots and limitations. A large part of this is due to my personal background. As an engineer, I am not well versed in health sciences. I do not have the proper training or the background to fully understand the situations in which a person would

need an AAC device. I also have never needed to use or have used an AAC device. Since I do not have firsthand experience with the technology, I am limited in my ability to intuitively evaluate a device. These limitations can be offset by finding better and more detailed literature about the experiences of people that use AAC devices.

References

Aldabas, Rashed. "Special Education Teachers' Perceptions of Their Preparedness to Teach Students with Severe Disabilities in Inclusive Classrooms: A Saudi Arabian Perspective." *SAGE Open*, vol. 10, no. 3, 2020, p. 215824402095065., https://doi.org/10.1177/2158244020950657.

    The research here is an evaluation of special education teacher's confidence in teaching students with severe disabilities in Saudi Arabia. Special education teachers were sent surveys for them to evaluate themselves. The data from the surveys shows that factors that makes teachers feel more confident are having Bachelor's or Master's qualifications rather than an Associate's, having more experience working with disabled children, and working with older children. There are also some feelings of being undervalued by principals and other staff. This research helps flesh out the feelings of the people that must communicate and work with children with disabilities on a daily basis.

Antunes, Thaiany & Oliveira, Acary & Hudec, Robert & Crocetta, Tania & Antão, Jennifer & Barbosa, Renata & Guarnieri, Regiani & Massetti, Thais & Garner, David & Abreu, Luiz. (2018). Assistive technology for communication of older adults: a systematic review. Aging & Mental Health. 23. 1-11. 10.1080/13607863.2018.1426718.

    This is a systematic review of a wide range of assistive communication devices for older people. Specifically looking at speech assistive technologies, the article reaches some conclusions. The article finds that research has found typing to be an effective input technique. When the user is unable to type, brain computer interfaces can facilitate near-conversation level communication. Eye tracking computer systems seem to be appealing to users but did not show an improvement of psychological state, appraisal of disability, or independence in tetraplegic patients. This review provides a compilation of important evaluations of AAC technology.

Bailey, Rita L., et al. "Family Members' Perceptions of Augmentative and Alternative Communication Device Use." *Language, Speech, and Hearing Services in Schools*, vol. 37, no. 1, Jan. 2006, pp. 50–60., https://doi.org/10.1044/0161-1461(2006/006).

    This study conducted interviews of children with speech affective disabilities and a member of their families. This is because the use of AAC devices is usually inconsistent between school and home. The families tended to expect increased independence, communication competence, and communication opportunities as a result of using the AAC devices. They perceived barriers to these to be limitations of the device, inadequate training on how to use the device, and the family member being able to understand the child without their device leading to reduced usage. This study shows how the use of AAC devices impacts and is impacted by the home life of the user.

Barbosa, Renata Thaís, et al. "Augmentative and Alternative Communication in Children with Down's Syndrome: A Systematic Review." *BMC Pediatrics*, vol. 18, no. 1, 2018, https://doi.org/10.1186/s12887-018-1144-5.

This review looks at various types of communication systems as evaluated by children with Down syndrome. These include speech generating devices, picture exchange communication systems, sign language, and computer-generated pictographs. Each of these methods is evaluated for its effectiveness and ease of use. This provides a good overview of the status of AAC devices.

Costantino, Maria Antonella, and Maurizio Bonati. "A Scoping Review of Interventions to Supplement Spoken Communication for Children with Limited Speech or Language Skills." *PLoS ONE*, vol. 9, no. 3, 2014, https://doi.org/10.1371/journal.pone.0090744.

This review evaluates the efficacy of AAC interventions for children with limited communication skills. The review concludes that this area of is not well researched and that solid evidence of the positive effect of these interventions still needs to be produced. The specialized nature of the research means that there is not enough people working on it. It is also difficult to conduct research on this topic due to the variability in disability, language, and technology. This review shines a light on how difficult the research on this topic is.

Higger, Matt, et al. Northeastern University, Boston, MA, 2016, pp. 1–6, *Fast Switch Scanning Keyboards: Minimal Expected Query Decision Trees*.

This article presents a method of creating decision trees for a user choosing to input a word into an AAC device. The goal is to have the minimum number of queries for a user to arrive at the word that they want to input. This new model works well as a decision tree generator, but its unintuitive design makes it more difficult to use. This article shows progress being made to improve AAC devices.

Higger, Matt, et al. Northeastern University, Boston, MA, 2019, pp. 1–9, *User-Adaptive Text Entry for Augmentative and Alternative Communication*.

This article presents a method of adjusting the options that a device presents to a user in case their input is incorrect. This involves a model trained on mistakes and corrections made by the user so that it learns the pattern of mistakes the user makes. The article finds that this method used for single-character querying is very time consuming. However, it does well on multi-character querying. However, as the number of choices presented increases, it becomes slower to input data. This shows more progress being made to improve AAC devices.

Iacono, Teresa, et al. "The Role of Augmentative and Alternative Communication for Children with Autism: Current Status and Future Trends." *Neuropsychiatric Disease and Treatment*, Volume 12, 2016, pp. 2349–2361., https://doi.org/10.2147/ndt.s95967.

The goal of this research was to synthesize evidence of AAC interventions for children with autism. The article finds that it is difficult to inform people about the efficacy of AAC device interventions due to variability in the quality of the studies. Since some studies report efficacy over a range of disability, information is limited on its efficacy for those with very complex communication needs. In addition, using AAC devices as a last resort for children can lead to learned helplessness, challenging behavior, and missed learning opportunities. This article shows the rarity of high-quality research on AAC usage.

Istanboulian, Laura, et al. "Barriers to and Facilitators for Use of Augmentative and Alternative Communication and Voice Restorative Devices in the Adult Intensive Care Unit: A Scoping Review Protocol." *Systematic Reviews*, vol. 8, no. 1, 6 Dec. 2019, https://doi.org/10.1186/s13643-019-1232-0.

This article aims to answer the question of what barriers and facilitators exist for patient communication for those with advanced airway in ICU. The inconsistent adoption of AAC devices in the ICU leads to limited information on the topic. This article demonstrates a demographic that uses AAC devices that may require a specific design.

Kim, Taeil, and Soogwan Doh. "Analysis of the Digital Divide between Disabled and Non-Disabled People in South Korea." *Asia Pacific Journal of Public Administration*, vol. 28, no. 2, Dec. 2006, pp. 231–261., https://doi.org/10.1080/23276665.2006.10779323.

This article aims to understand the discrepancy between technology usage between disabled and non-disabled people in South Korea. It assesses people on access, capacity, quantitative, and qualitative usage indices. It finds disabled people lower in all indices. In the youth group the biggest gap was in qualitative usage due to non-disability reasons. In the middle-aged group, the largest gap was access to technology, also due to non-disability reasons. This article provides some knowledge about the differences in technology use in general between disabled and non-disabled people.

Romski, MaryAnn & Sevcik, Rose. (1997). Augmentative and alternative communication for children with developmental disabilities. Mental Retardation and Developmental Disabilities Research Reviews - MENTAL RETARD DEV DISABIL RES. 3. 363-368. 10.1002/(SICI)1098-2779(1997)3:43.0.CO;2-T.

This article holds information about children that use AAC devices. When evaluating an image based AAC system, they find that the discrepancy between the image and the actual object can cause issues. It is difficult to teach the meaning of the symbol due to its arbitrary nature. How long the children are trained for and where they are trained plays a part in how well they use the device. This article provides some information on older research conducted on AAC devices.

Samuelsson, Christina, et al. "'It's Our Gang' - Promoting Social Inclusion for People with Dementia by Using Digital Communication Support in a Group Activity." *Clinical Gerontologist*, vol. 44, no. 4, 2020, pp. 418–429., https://doi.org/10.1080/07317115.2020.1795037.

The aim of this article was to contribute to the understanding of how people with dementia could use communication support in group interaction. This is done through evaluation of a particular subject's experience of a loosely guided social interaction. This article represents a digital aid in communication that is not meant for direct communication but for facilitating a conversation more generally.

Sofronievski, Bojan, et al. "Macedonian Speech Synthesis for Assistive Technology Applications." *2022 30th European Signal Processing Conference (EUSIPCO)*, 2022, https://doi.org/10.23919/eusipco55093.2022.9909778.

This research aims to create a system to synthesize speech Macedonian. This is done with one parametric and three deep learning speech synthesis models. The parametric model performed well compared to the more common deep-learning models while having lower resource demands proving that it is a viable candidate for synthesizing Macedonian. This article fulfills a dual purpose. It shows progress being made in AAC devices. It also shows how less spoken languages can be overlooked in the development process, excluding groups of people that speak to them.

Watts, Oliver & Wihlborg, Lovisa & Valentini-Botinhao, Cassia. (2022). Puffin: pitch-synchronous neural waveform generation for fullband speech on modest devices. 10.48550/arXiv.2211.14130.

The goal of the research is the creation of a neural vocoder for low-powered AAC devices. The technology developed uses pitch synchronous Inverse Short-Time Fourier Transforms to generate speech samples. It shows that this technique is useful to pursue full-band speech. It produces output comparable to baseline technologies with a fraction of the computational cost. This shows progress being made to have high quality text-to-speech in low-powered AAC devices.

Zinkevich, Anna, et al. "Making a Voice Heard: Evaluation of a New Service Delivery in Augmentative and Alternative Communication through Qualitative Interviews with People without Natural Speech." *BMC Research Notes*, vol. 16, no. 1, 2023, https://doi.org/10.1186/s13104-023-06310-5.

This article presents the results of interviewing patients on their experience of Germany's new service delivery to improve AAC care. The review is predominantly positive. Some problems noted are that caregivers sometimes speak for patients. The devices are sometimes too large or are difficult to keep charged. This article shows an example of more widespread and official incorporation of AAC devices into medical care.